College of Dupage
Math 2245-001: Linear Algebra
Monday, Wednesday 12:00 – 1:50 PM
BIC 3541

Contact Information:

Dr. Matt Wechter
Office: BIC 3530A
Email: wechterm@cod.edu
Phone: (630) 942-4405

Course Objectives and Topic Outline:

Course description to appear in catalog:
Geometric vectors and vector spaces, matrices and linear transformations, inner product spaces, eigenvalues and eigenvectors, the determinant function, and formal methods of mathematical proof.
Credit Hours: 4 Lecture Hours: 4 Lab Hours: 0
Prerequisite: MATH 2232 Calculus and Analytic Geometry II with a grade of "C" or better, or equivalent
A. General Course Objectives:
Upon successful completion of the course the student should be able to do the following:

1. Use the method of Gauss elimination to solve systems, find matrix inverses, evaluate determinants, and identify bases for various matrix subspaces
2. Perform the basic operations of matrix arithmetic such as addition, subtraction, scalar multiplication, and multiplication of two matrices when appropriate
3. Calculate the cofactors of a matrix, and use them to compute the determinant and inverse of a given matrix
4. Compute the equations of lines and planes in 3-space using vectors
5. Use the axioms of a vector space to determine whether a given set of vectors forms a vector space under the given operations
6. Determine whether a given set of vectors is linearly independent, spans, or forms a basis for a vector space or subspace
7. Use the axioms of an inner product space to determine if a scalar valued binary operation forms an inner product for the space
8. Use the Gram-Schmidt Process to construct an orthonormal basis from a given basis in an inner product space
9. Determine the least squares solution of a linear system of equations
10. Compute the transition matrix when changing from one basis to another in a vector space
11. Compute the eigenvalues and eigenvectors of a given matrix, and use this information to determine whether a matrix is diagonalizable and, if so, find the corresponding diagonalization matrix
12. Use the definition to determine whether a function between vector spaces is a linear transformation; and, if so, compute the kernel and range, and obtain matrix representations for the transformation with respect to various bases
13. Identify similarity invariants of a matrix/transformation

B. Topical Outline:

1. Matrices and linear equations
    a) Matrices defined as rectangular arrays of real numbers
    b) Examples from economics, biology, and analytic geometry
    c) Systems of linear equations written in matrix from
    d) Gaussian elimination
    e) Row echelon form of a matrix
    f) Existence and uniqueness theorems for solutions of homogeneous and non-homogeneous systems of linear equations.
    g) Numerical examples for 2, 3, and 4 variables
2. Geometrical vectors
    a) Two and three dimensional vectors
    b) Sums, differences, scalar multiples, associative and commutative laws
    c) Dot and cross products
    d) Equations of lines in two and three dimensions
    e) Equations of planes by vector methods
    f) Normals and orthogonality
    g) Direction cosines
    h) Components of vectors and vector operations in terms of components
    i) Correspondence between plane vectors at the origin and R^2
    j) Correspondence between space vectors at the origin and R^3
3. Determinants
    a) Definition as a function from matrices to the reals which is alternating and multilinear on the rows and columns
    b) Expansion in terms of cofactors
    c) Cramer's Rule
4. Vector spaces
    a) Definition of abstract vector space over the reals
    b) Examples of vector spaces
        i. R^2
        ii. R^3
        iii. Euclidean n-space
            A) Row and column vectors defines as n-tuples
            B) Linear transformations from R^n to R^n
        iv. Null space of a matrix
        v. Function spaces
        vi. Spaces of solutions of linear differential equations (optional)
        vii. Spaces of polynomials
    c) Linear combinations of vectors with geometric applications
    d) Linear dependence and independence
    e) Definition of dimension and proof of uniqueness for the finite case
    f) Subspaces
    g) Geometric examples and functions, spaces, and examples of subspaces
    h) Dimensions of subspaces
5. Eigenvalues and eigenvectors
    a) Definitions

b) Characteristic equation
c) Eigenspace
d) Diagonalization
e) Orthogonal diagonalization

6. Linear transformations
    a) Matrices associated with linear transformations with respect to different bases
    b) Sums and products of linear transformations
    c) Range and kernel of a linear transformation
    d) Elementary matrices
    e) Rank of a linear transformation and its associated matrix
    f) Row rank, column rank
    g) Inverses of linear transformations and matrices
    h) Calculation of an inverse matrix by elimination
    i) Similarity
7. Inner product spaces
    a) Orthogonal and orthonormal bases
    b) Gram-Schmidt process
    c) Distances
    d) Orthogonal complements
    e) Orthogonal expansions
    f) Application tp 3-dimensional analytic geometry
8. Additional topics - Up to 10 hours should be spent on topics chosen from below:
    a) Quadratic Forms
    b) Least Squares estimation
    c) Examples in function and polynomial spaces where the inner product is defined via an integral
    d) Applications chosen by the instructor

Textbook:

Elementary Linear Algebra, 12th ed. by Anton, Rorres (ISBN 978-1-119-40677-8)

Classtime:

Students are expected to attend class and PARTICIPATE. Students are responsible for all material covered in each class, even if they missed that day. Quizzes and exams will be held during class time.

While in class, students should be respectful of other students as well as the instructor. All students are welcome to share their thoughts and the classroom will be an inclusive space.

Students should not distract others with their computers or cell phones. Any distractible cell phone use should be done outside the classroom. All communication between instructor and students will be conducted either through Blackboard or via a COD email account. Make sure you check your COD email regularly.

Homework:

Homework will be assigned for every lecture. Students need to spend time and complete every assigned homework problem to master the material and be prepared for quizzes and exams. Homework

problems will appear on quizzes and exams.

Solution guides and online step-by-step solutions should not be overused when doing homework. Students who rely on these resources tend to underperform on exams. When stuck on a problem, take the time to read class notes and the textbook for related examples. Working with study partners or groups is highly recommended. Asking questions in class and at the Math Assistance Area is also highly recommended.

On the day of the final exam, every student should bring in all their completed homework. The instructor will choose *one* section of homework at random that each student will turn in. Evidence of completion of this homework (with work shown) will earn the student homework extra credit for the semester.

Quizzes:

Quizzes will usually require students to write proofs. Often, quizzes are questions inspired by the homework assignments. Partial credit is awarded on questions where correct work is shown. Calculators are NOT allowed on any quizzes.

Written Assignments:

There will be three written take-home assignments during the semester. These are questions supplemental to the homework which will ask students to prove certain theorems or look at specific examples. Solutions should be written up, showing all work in full detail, and handed in on the due date.

Students are encouraged to work together on these assignments but are not allowed to use published (online or printed) resources beyond our textbook for help. Students can seek help from COD faculty or tutors in the Math Assistance Area, but not from anybody else outside COD. Students should reference who at COD they worked with or received help from in their write-ups.

Exams:

There will be two (2) midterms and a cumulative final exam given in the course. Each midterm may cover new as well as old material, so understanding mistakes made in previous units will be beneficial.

The exams will be taken in-class. No new material will be covered on exam days. No cell phones or computers will be allowed at all at a student's desk during the exam.

The final exam will take place on Monday, December 11, as shown on the calendar. The final exam will cover all material from the semester.

“Free Passes”:

Each student is allowed two “free passes” for the semester, good for a 48-hour extension on any assignment. *No more than one* of these passes may be used on a unit exam, and a free pass cannot be used on the final exam.

The 48-hour extension begins from the original deadline of the assignment, and students *must* email the instructor or speak to them in class before the deadline to request the use of a free pass before submitting it. All exams or in-class quizzes must be taken in a COD Testing Center or using the Virtual

Testing Center. There are no extensions after the 48 hours, even if the Testing Center has limited hours during that time.

Attendance Policy:

There is a constant stream of new material, homework, and other assessments in this course. Students should be working every day to master the material and complete the assigned work. Taking an occasional day off each week is recommended to not become over-stressed, but doing no work for more than a day will usually cause students to fall behind and never catch up.

Exams CANNOT be made up after their due date under any circumstances except as an accommodation required by the Center for Access and Accommodations or a free pass was granted. Quizzes also cannot be made up after their due date unless a free pass is requested in a timely manner.

Grade Calculation:

Graded Assessment	**Percentage of Final Grade**
Homework	2% Extra Credit
Quizzes	20%
Written Assignments	16%
Exam 1	20%
Exam 2	20%
Final Exam	24%

Letter Grade	**A**	**B**	**C**	**D**	**F**
Percentage	89.5% and Up	79.5%-89.5%	69.5%-79.5%	60%-69.5%	Below 60%

Written Style:

Student should practice and use good style when answering problems to receive any partial credit. That means that any answer which requires an explanation should be written in complete sentences, all mathematical notation should be consistent and make sense, and anybody reading the solutions for the first time (namely, the grader) should have no confusion as to both the final answer and the work involved to get there. For example, “1 + 1 =2” is a complete sentence. It has a subject (1+1), a verb (=) and an object (2).

Academic Integrity:

Students should be aware of the Code of Academic Conduct and know the consequences should the

code be violated. The document can be found at

Code of Academic Conduct

If a student is caught violating the Code they will receive a grade penalty and will be reported through COD's academic integrity reporting system.

Student academic dishonesty includes but is not limited to**:**

- Dishonest use of course materials, such as student papers, examinations, reports and material posted on the Internet.

- Knowingly posting course materials of any kind on Internet sites such as (but not limited to) Course Hero and Chegg without the consent of the instructor.

- Knowingly assisting others in the dishonest use of course materials such as student papers, examinations and reports.

- Knowingly providing course materials such as papers, lab data, reports and/or electronic files to be used by another student as that student's own work.

- Plagiarizing, i.e., using language or ideas from materials without acknowledgement and/or copying work from other sources and submitting it as one's own.

- Examples of plagiarism include but are not limited to:

  § Copying a phrase, a sentence, or a longer passage from a source (including an Internet source) and submitting it as one's own.

  § Summarizing or paraphrasing someone else's ideas without acknowledging the source.

  § Submitting group assignments individually as one's own independent work.

  § Copying or taking pictures of course materials such as videos, exams, quizzes or assignments and posting the copied items and/or pictures on the Internet **or** sharing these copied items and/or pictures with other students who have not yet completed the assignments.

  § Taking pictures or copying course materials that are considered confidential by the instructor such as exams or quizzes.

If an exam is being proctored, students should comply with the proctor's instructions. If a proctor accuses a student of violating the Code of Academic Conduct or not conforming to the assessment's instructions, and the student does not agree with the accusation, the student should provide countervailing evidence to support their case. Students caught violating the Code of Academic Conduct will receive a 0 on that assignment and possibly further penalties depending on the nature of the violation.

Center for Access and Accommodations:

The College of DuPage is committed to the equitable access of educational opportunities for students with disabilities in accordance with The Americans with Disabilities Act, As Amended and Section 504 of the Rehabilitation Act of 1973. Any student who feels they may need an accommodation on the basis of an illness, injury, medical condition, or disability should contact the Center for Access and Accommodations to determine eligibility for accommodations and to obtain an official Letter of Accommodation. The Center for Access and Accommodations can be reached via email at access@cod.edu. Students may also initiate a request for services by going to www.cod.edu/access and clicking on the green box labeled "complete form to request accommodations." If you are already registered with the Center for Access and Accommodations, please email me your Letter of Accommodation as soon as possible. Please DO NOT send any private health documentation or Doctor's notes to the course instructor.

Covid-19 Policy

Students should adhere to COD's Covid-19 safety protocols throughout the semester if visiting campus. All relevant policies regarding masking, vaccinations, reporting can be found on the COD website at

https://www.cod.edu/coronavirus/index.aspx

If you have been exposed to Covid-19 or have been diagnosed with Covid-19, please fill out the Student Self-Reporting form at

https://cm.maxient.com/reportingform.php?CollegeofDuPage&layout_id=9

Withdrawal Policy:

The final day for a student to withdraw from any course will be equal to 75% of the time for the respective academic session (see the Registration Calendar) through myACCESS https://myaccess.cod.edu or in person at the Registration office, Student Services Center (SSC), Room 2221.

After the deadline, students will be required to appeal for late withdrawal and provide appropriate documentation to the Student Registration Services Office for all requests. Students who are granted approval to withdraw by petition will not be eligible for refunds of tuition or fees and will receive a 'W' grade on their transcript. Appeals must be submitted prior to the designated final exam period for 16-week classes and before the last class meeting for all other session classes